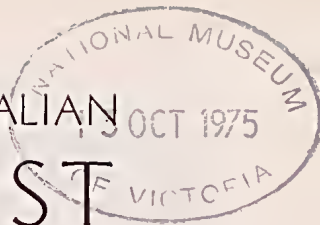


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## ZONAL FEEDING IN THE BIRDS OF CULEENUP ISLAND, YUNDURUP

By ALLEN KEAST, Queen's University, Kingston, Ontario

Zonal feeding in birds is determined by dividing the trees, shrubs, and ground, into a series of vertical levels and recording the relative amounts of feeding in each. Two alternative but comparable methods are used for the latter, assessing the amounts of *time* spent feeding in each zone by means of a watch, or counting the number of feeding actions (pecks) in each over a measured time interval. Balance is achieved by restricting the observations of any individual bird (I use half a minute) and flock (up to 4 minutes) spreading the observations over different hours of the day, observing a range of individuals, and carrying out the observations in a range of localities (Keast, 1968).

Because most observers are limited in the amount of time they can spend on a project the work is usually concentrated in the breeding season, it being argued that this is the time when there is likely to be the greatest competition for resources and when species feeding differences and separations are hence likely to be most clear cut. There is, of course, no doubt that studies of zonal feeding should be carried out throughout the year or, rather, during the four major seasons. It may change as the spatial distribution of dominant food resources change or when, due to nomadism or migration, the associated combination of species sharing the particular habitat changes. There have, however, been virtually no comparative studies made on a seasonal basis.

That closely related bird species may feed at different "levels", and that this is one of the devices whereby inter-specific competition is reduced has been recognised for some time. The first quantitative study, however, was that of Colquhoun and Morley (1943) on British tits (Paridae). These observers also noted that different species showed some preferences for different kinds of trees, i.e. conifers relative to deciduous. MacArthur (1958), and others, have noted that tree crown feeders may, alternatively, feed tangentially (i.e. working around the outside of the foliage), or radially (i.e. they enter the foliage by way of the branches). My observations indicate that this division is rarely absolute. In South-Western Australia, however, Weebills commonly obtain their insects from the foliage by fluttering around, and clinging to, the outer leaves whereas Broad-tailed Thornbills rarely do this, preferring either to approach the terminal leaves by way of the outer branches and twigs, or alighting amongst the twigs. Generally speaking large birds are radial feeders, their weight necessitating that they work out along the branch and reach into the foliage. Rufous and Golden Whistlers and, of course, Western Shrike-Thrushes, all being to a considerable degree branch feeders, also do this. Black-faced Cuckoo-Shrikes and Grey Fantails, by contrast, do some fluttering at the foliage.

In Table 1 are summarised the results I obtained over a couple of days field observing on Culeenup Island (September 14-15, 1974) in the mixed woodland there. The area is dominated by *Eucalyptus rudis* but there is a rich development of tall saplings and shrubs of all sizes. *Casuarina*, *Melaleuca* and *Kunzea* also provided tree-type feeding opportunities. Eleven categories of feeding level were allowed. Observations were made on the

TABLE 1. ZONAL FEEDING AT CULEENUP ISLAND

	Percentage in each Feeding Zone											
	No. of observations	Air	Foliage	Twigs	Branches Outer	Branches Inner	Trunk Upper	Trunk Lower	Sapl. Foliage	Sapl. Trunk & Branches	Low Shrub	Ground
Broad-tailed Thornbill	229	2	25	10	5	2		5	23	10	18	
Yellow-tailed Thornbill	185		5						40	15		40
Western Warbler	70		56	27	12						5	
Silveryeye	440		15	3	6	18	21	13	13		11	
Rufous Whistler	72	2	26	16	26	6			16	8		
Golden Whistler	35		10	30	30				30			
Red-tipped Pardalote	135		85	10	5							
Splendid Wren	45				10				45	10	35	
Scarlet Robin	30									20		80
Western Shrike-thrush	110		15		60	15				10		
Grey Fantail	72	60	20	5	5			5	5			
Willie Wagtail	26	55								10		35
Golden Bronze Cuckoo	20		80	20								
Pallid Cuckoo	25					10		10				80
Brown Honeyeater	85	5	25	20	10				40			
New Holland Honeyeater*	15	35	65									
Welcome Swallow	35	100										

\* Refers to insect-taking activity only. At virtually any time the relatively few birds present could be seen flower-probing.

basis of numbers of feeding actions (pecks), expressed as a percentage. I prefer such a counting method rather than recording time spent feeding in each area, both because it is more precise and because it is faster, on occasions permitting observations to be made simultaneously on members of two species.

A range of clear-cut results emerge from the Table. Apart from obvious knowledge that the Welcome Swallow is exclusively an aerial feeder (above treetop height or over fields and open water), the Red-tipped Pardalote emerges as virtually exclusively an outer foliage feeder (much of its time was spent in the tops of the loftiest trees), the Splendid Wren as a dense thicket and lower sapling feeder (on one occasion a male temporarily fed in branches at 30ft.) The Grey Fantail is an aerial insect feeder (60% of total feeding actions), with half the catches being made on sorties between trees (at or below canopy height), a third on short dashes within the branches or about the twigs, and the remainder within and about saplings. In addition insects were obtained from the foliage by fluttering around, or clinging to, the outer leaves. The two whistlers fed mostly at the middle regions or terminations of the branches, taking up vantage points and from there scrutinising the foliage, branches, and twigs above, below, and on either side. When a suitable prey item was spotted the bird hopped or quickly fluttered to it. On occasions, however, they hopped methodically through the dense outer foliage of trees or worked through the heavy foliage of saplings. They did not feed at heights of less than 6-8 ft. (in places, of course, the Golden Whistler does much feeding at heights of 4-8 ft.). The Western Shrike-Thrush differed from its smaller relatives in the greater amount of branch feeding. Observations on the Scarlet Robin and Pallid Cuckoo were too few to be quantitative. A fair degree of ground-feeding was indicated, however.

The writer was most interested in three species, the two thornbills and the silvereye. In the east, where the arboreal feeding Striated Thornbill and Little Thornbill are present, the Brown Thornbill is a low shrub and sapling feeder; the Yellow-tailed Thornbill largely a ground feeder. It very soon became apparent that here, as elsewhere in the South-West, the Broad-tailed Thornbill, the counterpart of and close relative of the Brown, feeds at all levels and has a marked foliage-gleaning component to the feeding. The Yellow-tailed Thornbill, likewise, has changed feeding habits, over half the feeding being carried out in the branches and foliage of saplings. The Western Silvereye proved to be extremely versatile. It fed virtually everywhere but in the air. There was a marked amount of trunk and branch feeding, with the birds working their way around these, or fluttering and clinging at all angles. Other feeding parties (or the same individuals later) assiduously worked the foliage of 60-80 ft. eucalypts, and saplings. Then a group would drop out of the trees to work over and through small 2-3 ft. high shrubs. From time to time individuals even probed the flowers of *Eucalyptus rudis* alongside the New Holland and Brown Honeyeaters, or, rarely, those of *Hardenbergia comptoniana*, the ground-clinging yellow-flowering *Conostylis aculeatus*, or the blossoms of the wattle, *Acacia cyanophylla*. One could not help speculating that there must have been a correlation between the trunk feeding of silvereyes and the local absence of the trunk-feeding sittellas and treecreepers. Silvereyes are, of course, both insect and berry feeders and, as such, are obviously amongst the most generalised feeders in the bush. I have never before this, however, seen them taking insects from such a wide range of vertical levels. The great versatility displayed in its feeding by this species in part must explain its success and abundance over wide areas.

Nectar feeding is very hard to measure by the methods used here. Even if one were to use the stop-watch method and come up with comparative figures for the amount of time spent nectar relative to insect feeding it would not help give a comparative picture of the actual weights of the two foods being consumed, or of the calorific or energetic value being obtained from each. Recher and Abbott (1970), for example, in stressing the relatively low nutritional value of nectar suggest that the

frequency with which meliphagids are observed aerial feeding stems from the need to supplement the diet with animal protein. All meliphagids are, of course, partly nectar-feeding, the amount varying with the species (see Keast and Condon, 1968). The New Holland Honeyeater would seem to be one of the least insectivorous species and, in fact except for once or twice, every time the 3 or 4 individuals on Culeenup Island were seen feeding it was at the flowers of *Eucalyptus rudis*. The much more abundant Brown Honeyeaters, however, only occasionally visited the flowers (which proved to be almost lacking in nectar). Instead these birds spent nearly all their feeding time taking insects from the branches and leaves of the riverside trees and saplings. They mostly worked their way into the leaves along the outer branches but, on a few occasions, fluttered at the outer foliage.

The above brief observations indicate that this method of quantification can be very rewarding for defining the ecological roles of series of cohabiting bird species and giving insight into mechanisms operating to minimise interspecific competition. They can be elaborated by making counts of the relative abundances of the different species (thereby coming up with a measure of the actual "pressure" being exerted by each species on its specific range of food resources). Insectivorous species also differ, of course, in the sizes of prey items taken. Overseas work brings out that there is a broad correlation between prey size and bill size, in birds. A superficial survey of the Australian literature on stomach analyses indicates that this is also true here. It can be inferred, hence, that the different bill sizes of a thornbill, a whistler, and a shrike-thrush "channel" them towards insects of different sizes and that these three are never in competition.

Studies such as the above should be carried out at a range of localities in South-Western Australia, and elsewhere. Culeenup Island, in itself, merits analysis at the height of the breeding season, and at all other times of the year.

#### APPENDIX—SCIENTIFIC NAMES OF BIRDS DISCUSSED

Pallid Cuckoo—	Scarlet Robin—
<i>Cuculus pallidus</i>	<i>Petroica multicolor</i>
Golden Bronze-Cuckoo—	Grey Fantail—
<i>Chrysococcyx plagiatus</i>	<i>Rhipidura fuliginosa</i>
Welcome Swallow—	Willie Wagtail—
<i>Hirundo neoxena</i>	<i>R. leucophrys</i>
Black-faced Cuckoo-Shrike—	Golden Whistler—
<i>Coracina novaehollandiae</i>	<i>Pachycephala pectoralis</i>
Splendid Blue Wren —	Rufous Whistler—
<i>Malurus splendens</i>	<i>P. rufiventris</i>
Western Warbler—	Western Shrike-Thrush—
<i>Gerygone fusca</i>	<i>Colluricincla rufiventris</i>
Weebill—	Black-capped Sittella—
<i>Smicrornis brevirostris</i>	<i>Neositta pileata</i>
Striated Thornbill—	Rufous Tree-creeper—
<i>Acanthiza lineata</i>	<i>Climacteris rufa</i>
Little Thornbill—	Red-tipped Pardalote—
<i>A. nana</i>	<i>Pardalotus substriatus</i>
Brown Thornbill—	Western Silvereye—
<i>A. pusilla</i>	<i>Zosterops gouldi</i>
Broad-tailed Thornbill—	Brown Honeyeater—
<i>A. apicalis</i>	<i>Lichmera indistincta</i>
Yellow-rumped Thornbill—	New Holland Honeyeater—
<i>A. chrysorrhoa</i>	<i>Phylidonyris novaehollandiae</i>

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## "MISS NORTH'S TREE," WARREN NATIONAL PARK

By D. L. SERVENTY and G. G. SMITH, Nedlands

In the article on "Historic Trees," in the *Australian Encyclopaedia*, 1958, vol. 9, p. 31, is listed "Miss North's Tree," a large karri in the Warren National Park, south-west of Pemberton. Mr. B. J. Beggs, Conservator of Forests, has supplied us with some data on the tree, which is situated on high ground on the edge (south side) of the Old Vasse Road which traverses the Warren National Park on the north side of the Warren River. It is slightly over 4 km west of the point where the Old Vasse Road leaves the Northcliffe Road near Warren House, the old Brockman homestead. Mr. Beggs adds that the tree "has a height of 55 metres with a girth measurement of 5.6 metres. At a height of about 12 metres a large burl or 'niggerhead' completely rings the bole. The tree is overmature with decadent crown and has many epicormic limbs for the full length of the bole. There is a weathered plaque at the base of the tree inscribed 'Marianne North Tree'."

The tree is notable because it was painted by Miss Marianne North, the English botanical artist and traveller, when she stayed with her kinsman, Edward Reveley Brockman (1838-1902), at Warren House, near Pemberton, in December 1880 (*Recollections of a Happy Life*, 1892, vol. 2, pp. 164-166). She does not actually mention this particular tree in the book, though she was vastly impressed with the large size of the trees in this magnificent forest, where, on one occasion, "I spent four delightful hours sketching or resting under these gigantic white pillars, which were far more imposing than the trees of Fernshaw" (the Mountain Ash in Victoria).

Her painting of the tree hangs in the North Gallery at the Royal Botanic Gardens, Kew, a building she had erected at her own expense to house her considerable collection of botanical paintings. It was opened to the public in 1882. The *Official Guide to the North Gallery*, 6th edn., 1914, p. 121, no. 782, has the following description, by Miss North herself: "*Karri Gums, near the Warren River, West Australia*. Casuarinas and Emus in the foreground. The Karri Gum trees (*Eucalyptus diversicolor*, F. Muell.) are among the tallest trees in the world. Baron Mueller states that he has seen many of them that approached 400 feet in height\*. One of those painted has a monstrous ring of warts around the trunk, reminding one of the columns of Milan Cathedral, the trunks being as white and polished as the pillars themselves."

The painting is about 12 x 18 in. In the foreground are casuarinas (which must be *Casuarina decussata*) and emus, on the track or a clearing. There are also bracken, zamia palms and *Leucopogon verticillatus*.

\*Actually neither the Karri nor the Mountain Ash (*Eucalyptus regnans*) have been proved to reach this height; the Karri approaches 300 feet, and the tallest known Mountain Ash was 375 feet.